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To: J. C. Bresee

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Abstract

Events leading to the explosion of the intercycle evaporator in Cell 6 of the Hot Pilot Plant, Building 3019, are described and photographs of the ruptured evaporator are included in the first paper. The second paper describes the decontamination program for the interior of Building 3019 and summarizes the current condition of the building. Statements made in these papers are to be considered preliminary. A forthcoming report, ORNL-2989, "Intercycle Evaporator Explosion, Building 3019, Oak Ridge National Laboratory," will contain the detailed and final analysis of the incident and subsequent events.

INTERCYCLE EVAPORATOR EXPLOSION, BUILDING 3019

Presented at a Chemical Technology Division Seminar, July 19, 1960.

by
Lester J. King

On November 20, 1959 at 10:58 p.m., the evaporator explosion occurred in Cell 6 of the Hot Pilot Plant, Building 3019. The explosion was due to a deflagration of nitrated organic compounds and most probably involved the nitration by concentrated nitric acid of 14 liters of the proprietary decontaminating agent, Turco 4501. The evaporator was ruptured and the dry-stacked, barytes concrete block unit shielding wall was knocked down. The door to Cell 6, which is at ground level, was thrown against a dry-stacked concrete block wall and knocked the wall down.

Something on the order of 15 grams of plutonium was released from the evaporator cubicle. Of this, about 70 mg was released to the interior of Building 3019 and 600 mg was released through the Cell 6 door to areas outside of Building 3019.

No one was injured and no one received a significant fraction of a lifetime body burden of plutonium either at the time of the accident or during clean-up operations.

The processing cells were built in 1943 as part of the pilot plant for demonstrating the bismuth phosphate process for the recovery of plutonium from irradiated natural uranium. In 1949 the building surrounding the cells was extensively remodeled. Since then a number of processes were demonstrated. (Redox, Hexone-25, TBP-25, Purex, Thorex.)

At the time of the explosion the building contained the high level solvent extraction plant for the first cycle decontamination of power reactor fuels and the Volatility Process for recovering uranium from fused salt reactor fuels.

The portions of the building which are used by the PRFP pilot plant are an operating area, chemical makeup area, office area, penthouse over the cells, and five concrete shielded cells containing the radioactive chemical processing equipment. The cells are 20 x 20 x 27 ft deep and have 5 ft thick walls on three sides and a 4 ft thick wall on the south side. Figure 1 is a sectional elevation of Building 3019.

The aqueous feed to the PRFP plant contains uranium, plutonium, and fission products. In the extraction column, the uranium and plutonium are extracted into the organic phase. This is fed to the two parallel strip columns where the uranium and plutonium are changed from the organic to the aqueous phase.

The aqueous stream from each of the strip columns is fed to one of two intercycle evaporators where it is concentrated and collected in catch tanks for transfer to Metal Recovery for further processing. The evaporator which exploded was one of the two intercycle evaporators. Figure 2 is a drawing of the evaporator loop.

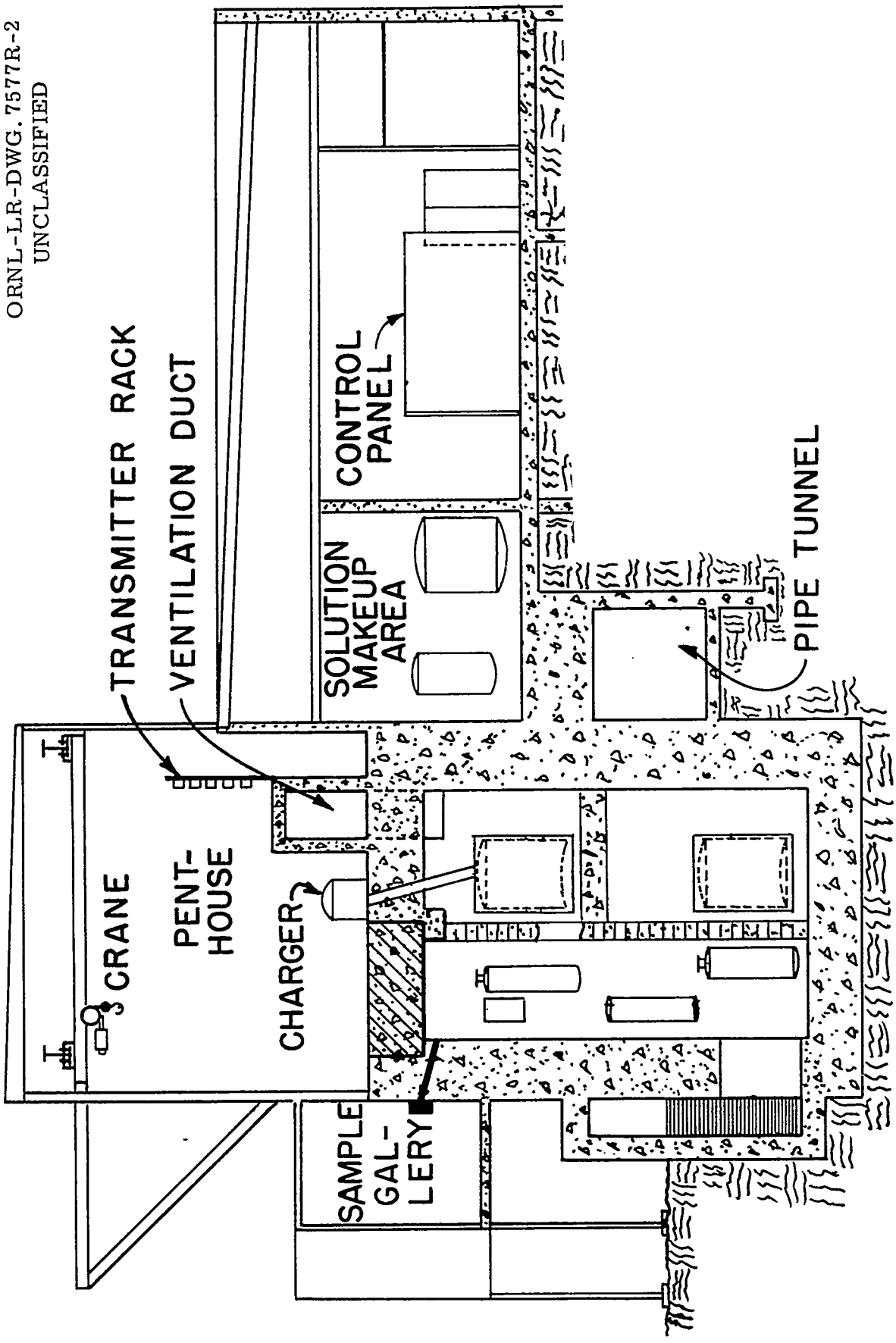
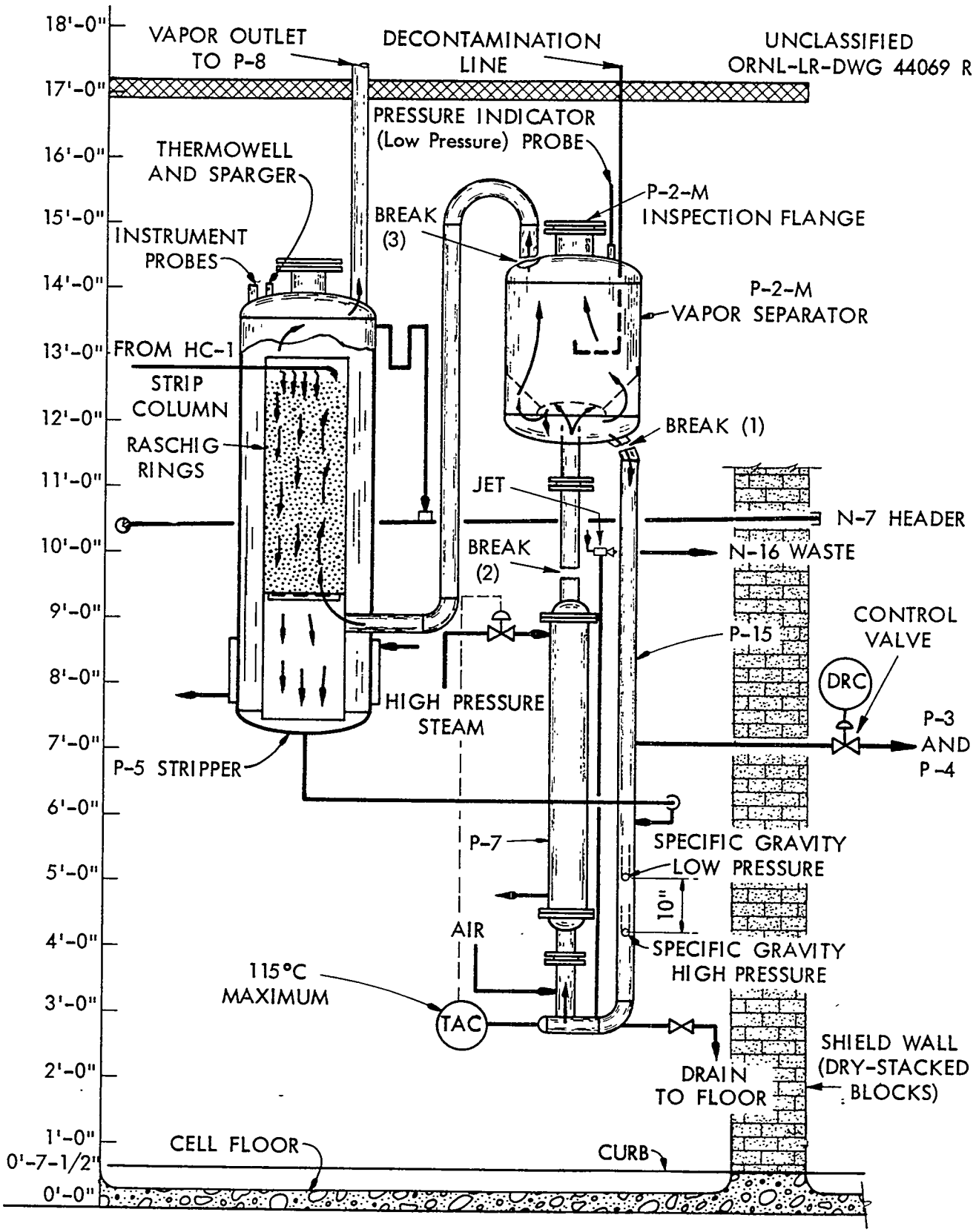


Fig. 1. Sectional Elevation Through Cell 5.



P-15 EVAPORATOR

Fig. 2. Scale: 1/2" = 1'-0"

The units which comprised P-15 evaporator loop are (or were) a steam stripper (P-5), a vapor separator (the late P-2), a 25 ft^2 heat exchanger (P-7), and connecting piping. Overhead vapor from the evaporator is condensed in a 35 ft^2 heat exchanger (P-8) and collected in condensate catch tank, P-6, which is shared by the two evaporator loops.

In normal operation the uranium-plutonium bearing aqueous stream from the strip column flowed by gravity through the steam stripper (for removal of dissolved and entrained organic) to the natural convection evaporator loop. Overhead vapor from the evaporator was routed from the vapor separator through the packed section of the steam stripper (P-5), where it served as the stripping medium, and then to the overhead condensate collection system.

Notice the drain line, with the manually operated valve, at the bottom of the loop, and the product outlet line, with the density-controlled automatic valve, some distance from the bottom. The volume of the loop below the product outlet line was 16.5 liters.

The cubicle containing the P-15 evaporator contained radiation levels above 100 roentgens per hour and caused high background levels throughout cells 6 and 7 and in the street south of the building. Decontamination was started to allow useful working times for equipment maintenance and for installation of more shielding around P-15 cubicle.

The evaporator was treated with boiling Turco 4501, a water rinse, a treatment with hot 30% nitric acid, and another rinse.

This treatment did not produce a significant reduction in the radiation levels. The manually operated drain valve was opened. Since this valve was located in a 100 r/hr field it was not often used. The evaporator was flushed with 200 gallons of water, 400 liters of hot 25% NaOH, and 300 gallons of water. The drain valve was closed at 3:00 p.m. on November 20 and the last series of treatments to the evaporator was begun.

It is felt that only those chemicals which were added to the evaporator after this closing of the drain valve have bearing on the subsequent explosion.

A solution of 200 liters of Turco 4501 and 62 liters of water (from steam jet dilution) was added to the evaporator. The lower 15% of the Raschig ring container was immersed. This solution was boiled for two hours during which it was concentrated to 238 liters. The solution was drained through the density control valve leaving the 16.5 liter drain heel. This heel probably contained 13.9 liters of Turco 4501 and 2.6 liters of water.

The next addition to the evaporator was 270 liters of approximately 4 M HNO_3. The heat exchanger steam was turned on and an 85 min boildown was started. This was originally scheduled to last somewhat longer.

Here are the keys to the explosion. If there had been no heel left from the Turco 4501 treatment, if the evaporator had been water flushed

before the acid addition, or if the steam had not been turned on - there would have been no explosion.

Turco 4501 is a strongly basic solution of the alkali salts of various organic hydroxy acids, various amines, surface active agents, and phenol.

A forthcoming report, ORNL-2979, by Wallace Davis, Jr., W. H. Baldwin, and A. B. Meservey is titled "Chemistry of the Intercycle Evaporator Incident of November 20, 1959." It lists the reactions which take place when a mixture of nitric acid and Turco 4501 is heated and describes the results of laboratory tests which involved the heating of Turco 4501 or its components with nitric acid. The authors conclude that, just prior to the explosion, the evaporator probably contained (1) in the steam stripper (P-5) about 30 liters of 30-35% HNO_3 (5.6 to 6.7 M), (2) in the convection loop about 18 liters of the products from extensive nitration of the Turco 4501 and some unknown quantity of phosphoric acid and butyl nitrate from the nitration of tributyl phosphate degradation products. The convection loop may have contained solid alkali nitrates and two to three kilograms of picric acid.

At 10:58 p.m. on November 20, 1959 the evaporator exploded. The explosion was certainly the result of the deflagration of the nitration products which were formed during the preceding 85 minutes.

Figure 3 through 9 are photographs of the evaporator and cell 7 after the explosion.

The three chemical operators and foreman were in the control room. They heard the explosion and felt the building shake. They saw the make-up room filling with a fog and the building was evacuated. The foreman and one operator put on gas masks and went back into the building to make a quick check for radiation and to secure the plant.

Operating, Health Physics and management personnel were called to the plant. Access to the area was restricted. A plan was initiated to evaluate the situation and start clean-up operations.

The area was smeared and Figure 10 is a map of the fallout pattern. One microgram of plutonium-239 undergoes 1.36×10^5 alpha disintegrations per minute and transferable contamination ran as high as 7.2×10^6 alphs disintegrations per minute per square inch. The central area contained one body burden of plutonium per 100 cm^2. Some beta-gamma activity (later identified as Zr^{95}-Nb^{95}) was found but it was not significant. The interior of the Graphite Reactor building became contaminated and the building was evacuated. Some contamination was found in other buildings but it was slight and was readily cleaned up.

By a variety of somewhat different but equally questionable methods it has been estimated that about 15 grams of plutonium was released to the cell area (exclusive of the evaporator cubicle), approximately 1.5 grams to the cell ventilation filters and 0.07 grams (70 milligrams) to the rest

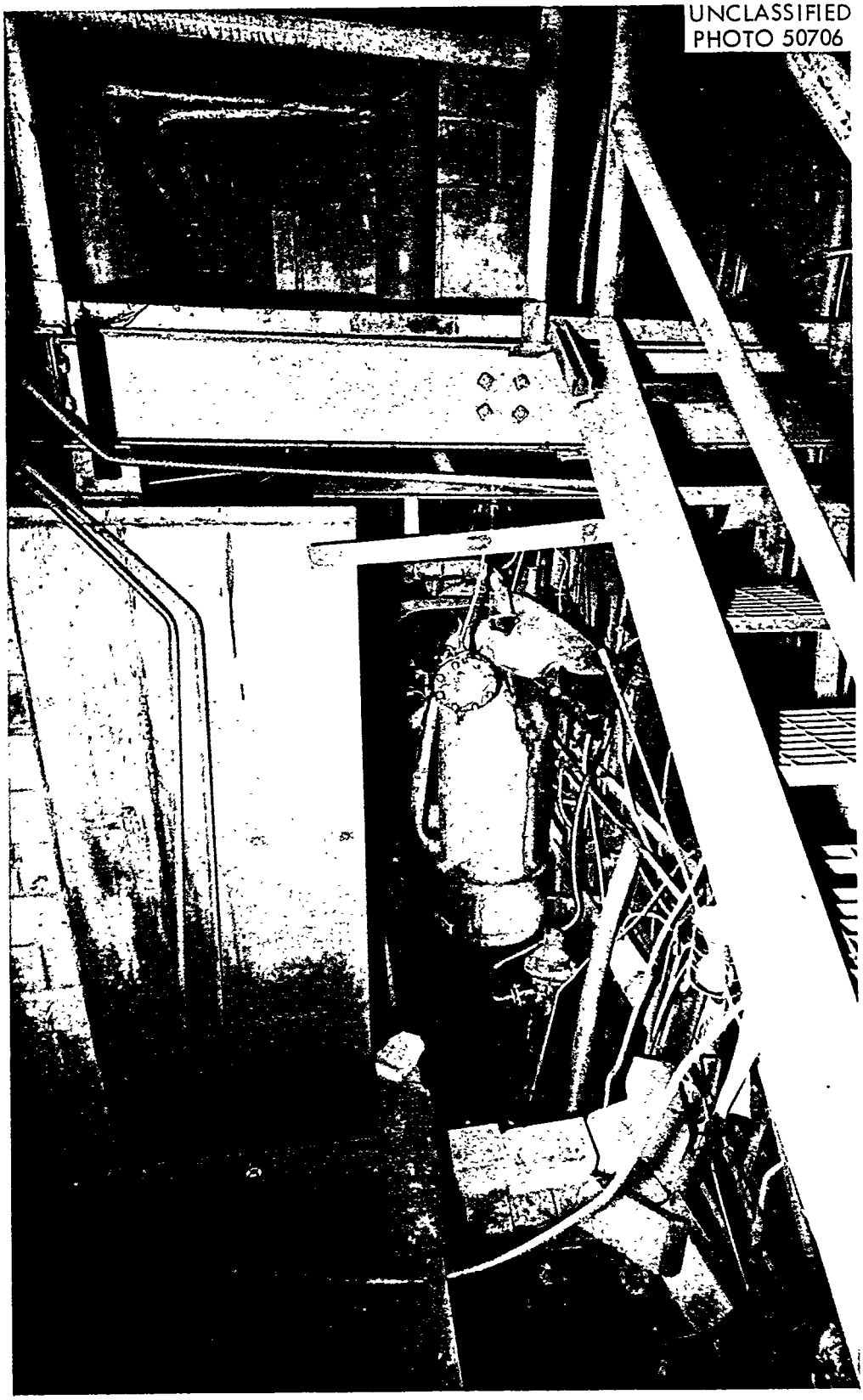


Fig. 3. Evaporator Cubicle.

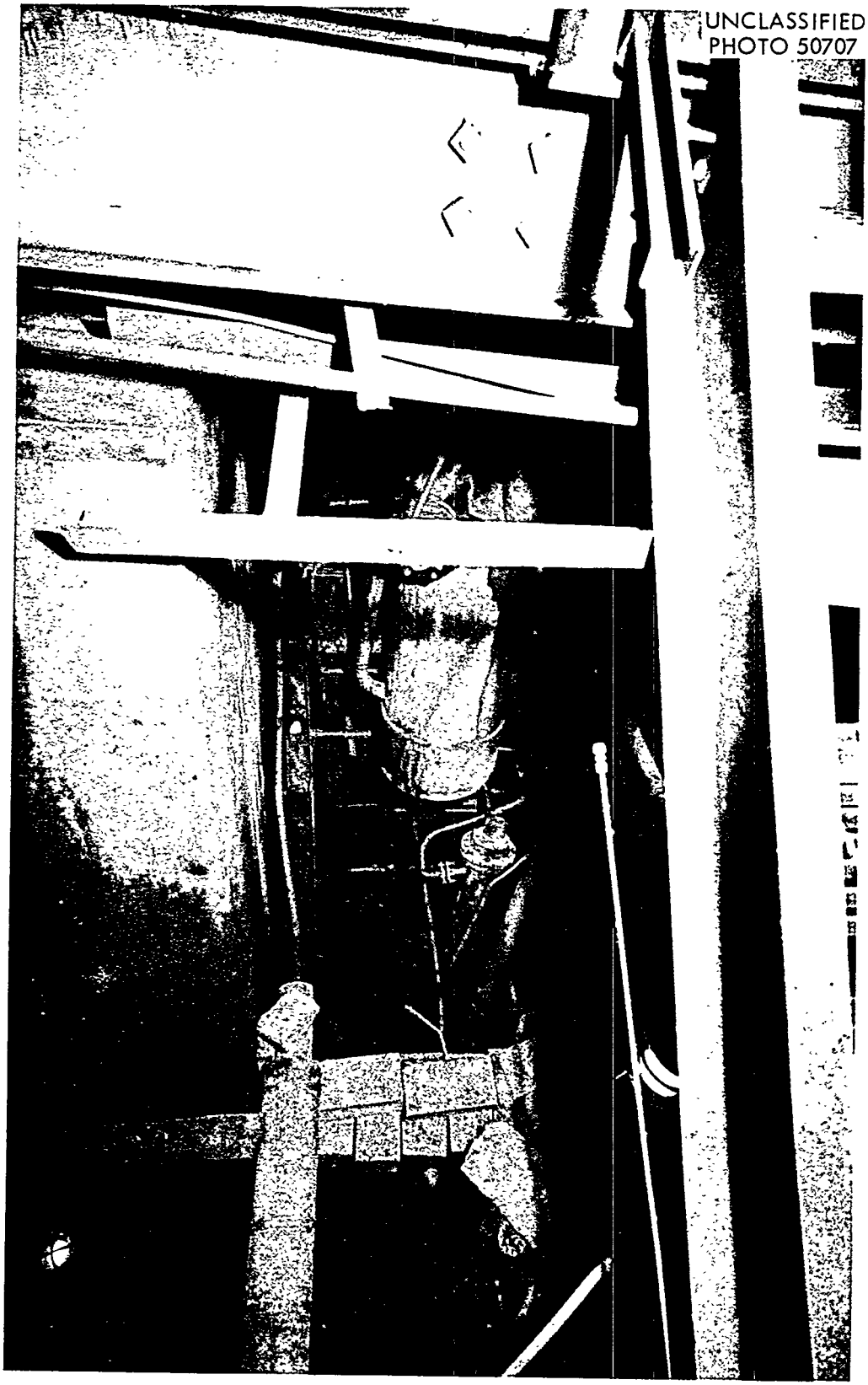


Fig. 4. Evaporator Cubicle.

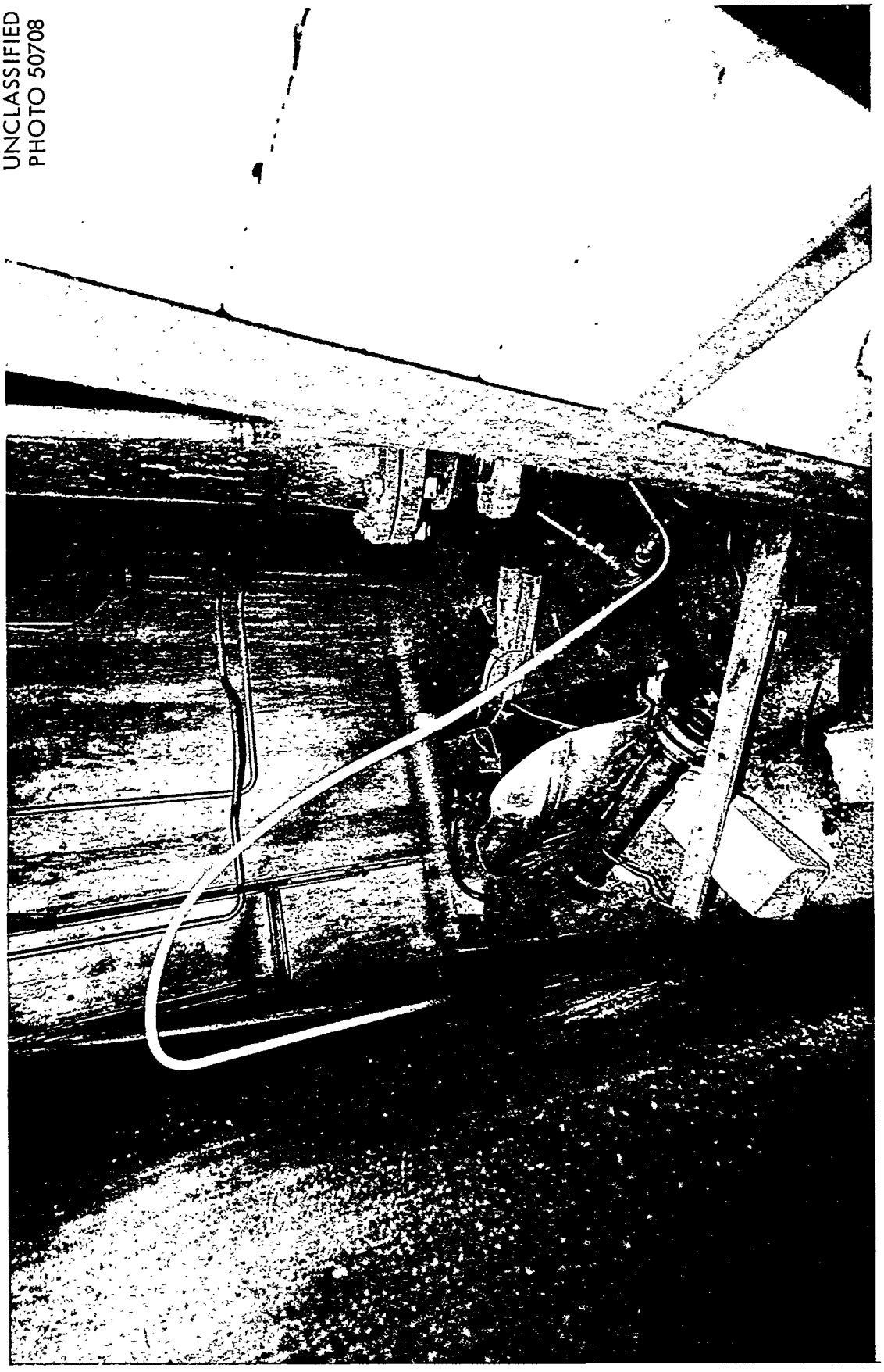


Fig. 5. Cubicle Floor.

Fig. 6. Cubicle Floor.

Fig. 7. Top of Heat Exchanger.

Fig. 8. Pipe Removed from Cubicle.

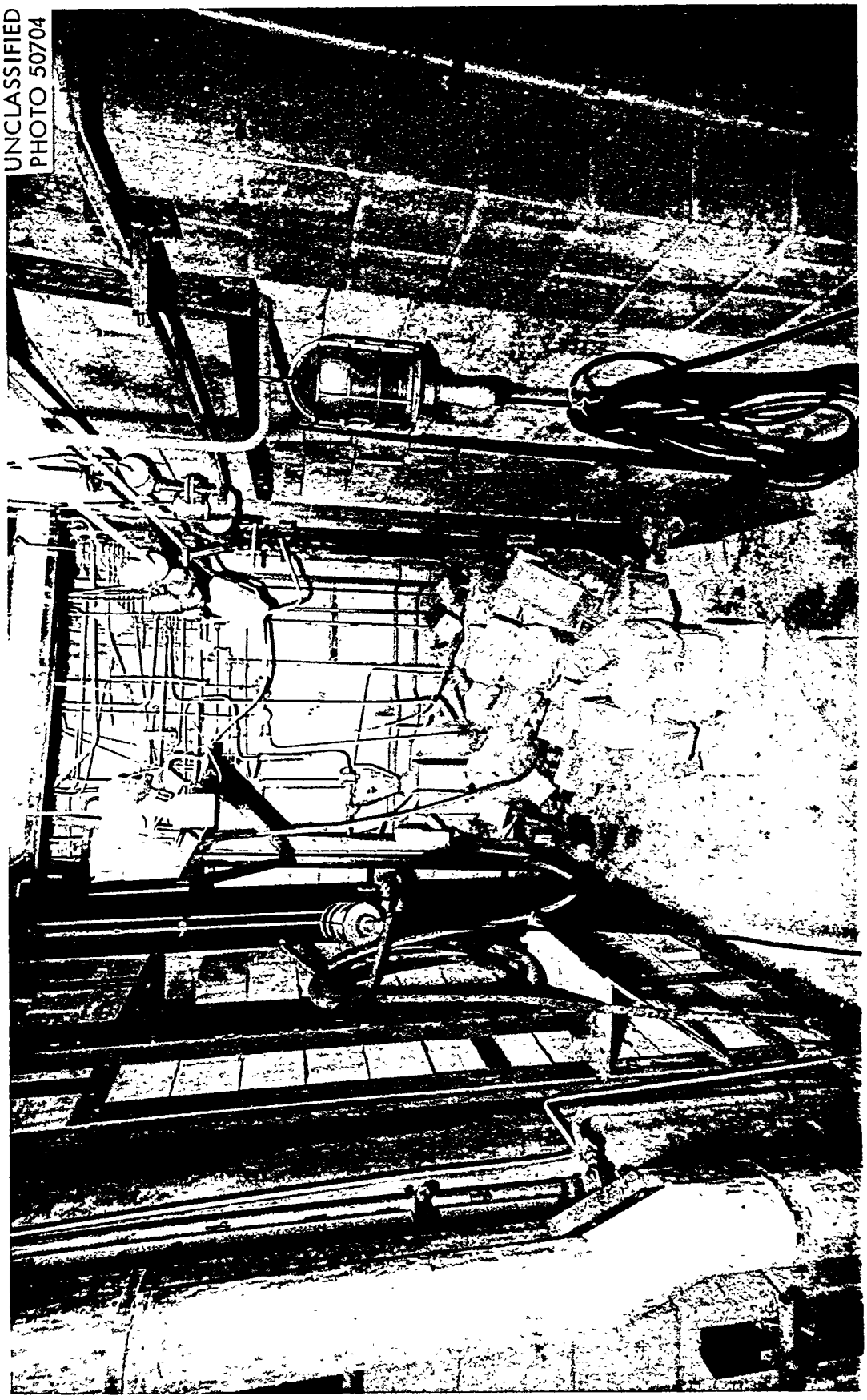
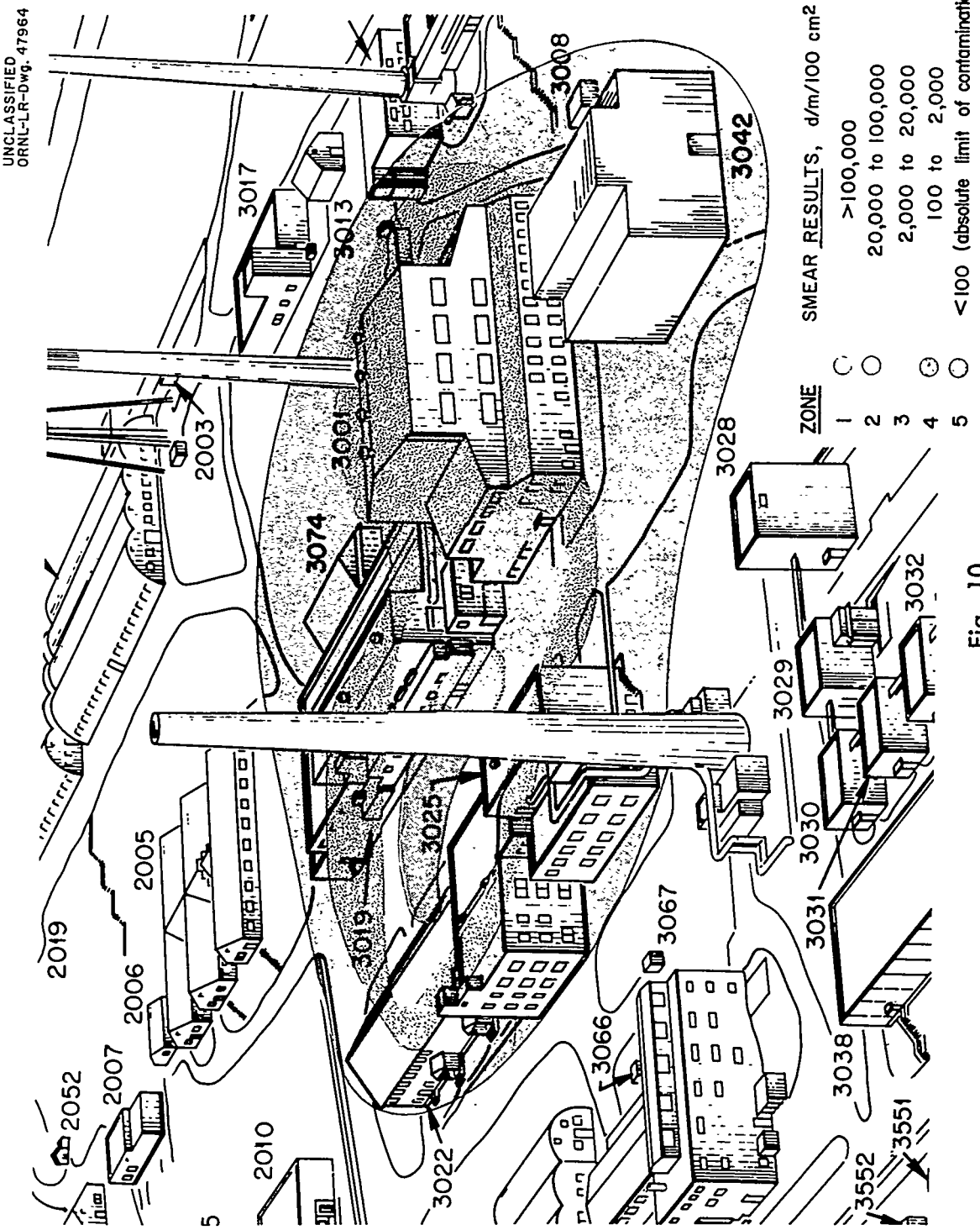


Fig. 9. East Wall of Cell 6.


UNCLASSIFIED
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SMEAR RESULTS, d/m/100 cm²
ZONE
1 >100,000
2 20,000 to 100,000
3 2,000 to 20,000
4 100 to 2,000
5 <100 (absolute limit of contamination)
2052
2007
2019
2006
2005
2010
2003
3017
3013
3008
3042
3001
3074
3028
3025
3019
3022
3029
3032
3030
3031
3067
3066
3038
3551
3552

Fig. 10.

of Building 3019. Approximately 600 milligrams was released through the cell 6 door to areas outside the building.

This brings up another factor which contributed greatly to the severity of the incident.

The building obviously was not designed to contain the plutonium which was released from the evaporator by the explosion. As a matter of fact, the explosion could not have occurred in a worse place. The evaporator is located about 20 feet from the only ground-level door in any of the cells. If the Cell 6 door had not opened (or better yet, if the door had not existed) the plutonium release might have been confined to Building 3019. The cell ventilation filters retained the alpha activity with a high degree of efficiency. The filter bank is composed of two layers of roughing filters followed by an absolute or high efficiency filter. Of 1500 milligrams retained on the filters, 1326 mg was on the first roughing filter, 156 mg on the second roughing filter and only 18 mg on the absolute filter.

The decision was made to immediately "fix" the plutonium with paint on the buildings and grass, with asphalt on the roads, and with either paint or tar on the roofs.

The weekend was spent fixing alpha activity to contaminated surfaces with paint, tar, roofing compound, or masonry sealer as was appropriate to the surfaces.

With the exception of the Pilot Plant portion of Building 3019 and the Graphite Reactor Building and Hillside Road between Third Street and the O.R.R. (Building 3042), all areas of the Oak Ridge National Laboratory were back in service by Monday morning, November 23.

It has been reported that the cells are inaccessible to clean-up crews because of high beta-gamma radiation levels. This is not really true. The cells do contain high beta-gamma radiation levels and working time is limited. Airborne alpha activity of over 100 times masking level dictates that entry to the cells be made in plastic suits with fresh air supplies. These high activity levels certainly hamper clean-up efforts but the cells are not inaccessible. They have been entered 7 times since the explosion. (Shield in door, smear, insert in sump, inspect cubicle prior to flushing, install lights and make radiation survey, photos for planning clean-up.)

One of the reasons that progress in cell clean-up has been slow is that the cell area could be quickly sealed and ignored while more pressing clean-up operations proceeded. When cell clean-up was finally started, it was decided to flush the evaporator with solution containing the neutron poison boron in the form of boric acid. A poisoned water flush of the evaporator produced 9 grams of plutonium and a poisoned solution of 6 M HNO_3 containing a small amount of fluoride produced 100 grams of plutonium. It was obvious that the clean-up operation would be as hazardous as any other program planned for the building. Clean-up stopped until the proper containment could be provided and vessel off-gas vacuum could be improved.

In summary, the explosion was due to a deflagration of nitrated organic compounds which were formed when a solution of nitric acid and 14 liters of the organic decontaminating agent, Turco 4501, was boiled. These materials were brought together by the failure to flush the evaporator between treatments and by the existence of a 16.5 liter heel in the equipment. The building design was obviously inadequate to prevent the spread of contamination to the environment from an accident such as this. It is unfortunate, indeed, that the explosion occurred directly opposite the only ground level door in the cells. It is fortunate that the accident happened at night when there were but a few people at the Laboratory. It is fortunate that most of the activity had been removed from the equipment. It is most fortunate that the people who were directly involved - those people who were at the Laboratory when the accident occurred and those who arrived within 20 to 30 minutes after being notified of the accident - were people about whom the committee which investigated the incident could say - and I quote from the official report of that committee to the Atomic Energy Commission - "Under the circumstances, the subsequent action of the pilot plant operators, shift supervisors, health physicists could hardly be improved upon. With but few exceptions they took prompt, direct, and, in retrospect, correct actions to minimize further damage to personnel and facilities."

DECONTAMINATION OF BUILDING 3019

Presented at a Chemical Technology Division Seminar, July 19, 1960.

by

W. T. McCarley

1.0 INTRODUCTION

Immediately after the evaporator explosion of November 20, 1959, in which approximately 15 g of plutonium was scattered in Cells 6 and 7 and the adjacent operating areas of Building 3019, an extensive decontamination program was begun. This afternoon I will briefly discuss the building contamination status after the incident, the contamination limits set as program goals, the decontamination methods used and the results of the program.

2.0 CONTAMINATION LEVELS

Figure 1 represents a sectional view of the pilot plant building and shows the levels of contamination inside the building after the explosion. I would like to emphasize the fact that high levels of contamination existed in several areas of the pilot plant prior to the evaporator explosion and the contamination levels represented by this figure and the decontamination effort expended during the past 8 months were not due entirely to the Pu contamination released by the explosion of November 20. Cells 6 and 7, where the evaporator is located, were the most highly contaminated areas with smear counts running as high at 10^8 d/m/100 cm^2. There are a total of 38 access holes penetrating the walls and ceiling of Cells 6 and 7, which are either completely open or partially filled with piping. The distribution and cross sectional areas of these access holes are as follows: penthouse - 19 holes (2.85 ft^2), pipe tunnel - 11 holes (2.15 ft^2), sample gallery - 2 holes (0.4 ft^2), make-up area - 6 holes (1.18 ft^2). The pressure from the explosion forced activity through these holes and contaminated the areas as indicated on Figure 1. The penthouse was the most highly contaminated area outside of the cells with smear results ranging from 5,000 to 50,000 d/m/100 cm^2. Direct probe measurements were as high as 800,000 d/m/100 cm^2. The sample gallery, make-up area and pipe tunnel were contaminated to approximately the same levels. Smear results in these three areas ranged from 1000 to 5000 d/m/100 cm^2. There are two open doorways between the make-up area and the control room and a small amount of activity drifted into the control room and office areas and they were contaminated to the levels as indicated in Figure 1.

Cells 1 through 5 and the analytical facilities in the west half of the building were not extensively contaminated by this incident.

3.0 CONTAMINATION LIMITS - GUIDES FOR DECONTAMINATION

To assist in determining the amount of decontamination effort to be spent on a particular area, acceptable contamination levels were set as guides (Table 1).

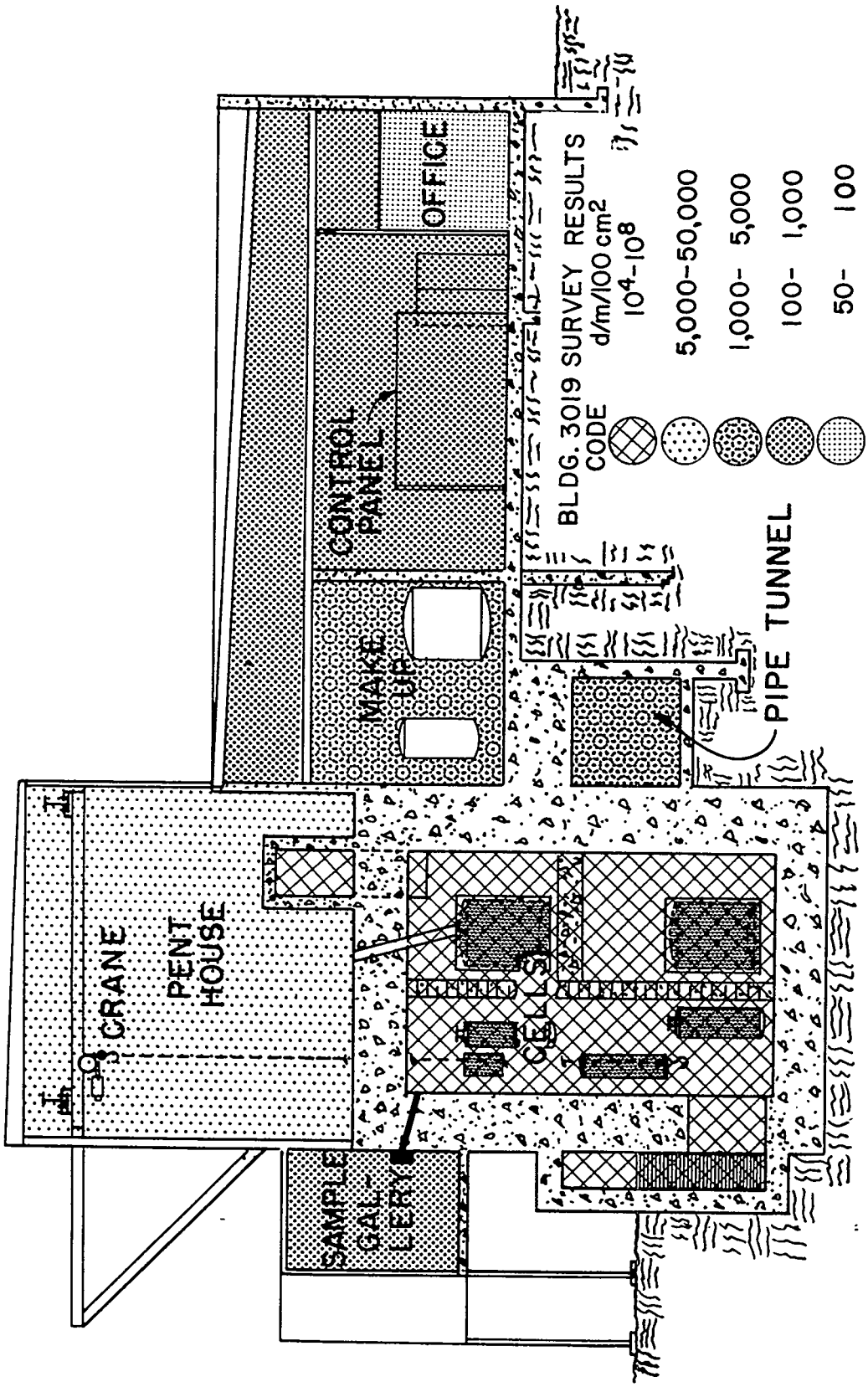

Fig. 1. Bldg. 3019 Contamination Levels after the Evaporator Explosion.

Table 1. Contamination Levels to be Used as a Guide for Establishing a Technical Noncontaminated Area for Exposed Surfaces in an Area where Extensive Contamination with Hazardous Alpha Emitters such as Plutonium are Involved

	Direct Reading	Transferable
Maximum Value	300 d/m/100 cm^2	30 d/m/100 cm^2
Average*	$\leq$ 30 c/m/100 cm^2	$\leq$ 3 d/m/100 cm^2

*The number of samples considered in deriving an average shall include at least 10 samples and there shall be at least one sample from each square meter of the projected surface area.

In areas where it was possible to remove essentially all surface contamination these limits were set. For direct readings a maximum of 300 d/m/100 cm^2 was allowable with an average equal to or less than 30 d/m/100 cm^2. For transferable contamination a maximum of 30 d/m/100 cm^2 with an average equal to or less than 3 d/m/100 cm^2 was set. In areas meeting these requirements it was not necessary to paint the ceiling and walls and the area was designated as a noncontamination zone. Only the offices were decontaminated sufficiently to meet these requirements.

In other areas where complete clean-up was not feasible, these limits were set (Table 2). For direct probe readings a maximum reading of 3000 d/m/100 cm^2 with an average equal to or less than 300 d/m/100 cm^2 was set. For transferable contamination the maximum was set at 300 d/m/100 cm^2 with an average equal to or less than 30 d/m/100 cm^2. After areas had been cleaned to these levels, remaining contamination was then fixed with a bond such as paint or concrete and the area remained designated as a contamination zone. Most of the areas in this category, such as the pipe tunnel and sample gallery, are normally designated as contamination zones so this was no disadvantage.

Table 2. Contamination Levels to be Used as a Guide in the Establishment of Controls over the Exposed Surfaces in an Area Extensively Contaminated with Hazardous Alpha Emitters where Complete Clean-up is not Feasible and the Contaminant will be Permanently Fixed to the Exposed Surfaces by a Bond such as Paint or Concrete

	Direct Reading	Transferable
Maximum Value	3000 d/m/100 cm^2	300 d/m/100 cm^2
Average	$\leq$ 300 d/m/100 cm^2	$\leq$ 30 d/m/100 cm^2

4.0 DECONTAMINATION PROCEDURES

Before actual decontamination effort was begun, it was necessary to set up strict rules for entering and leaving contaminated areas to prevent the spread of contamination into clean areas. Also, maximum protective clothing requirements for contaminated zones were designated as two (2) sets of coveralls, two (2) pairs of shoe covers, two (2) pairs of rubber gloves, assault masks, hood, and wrists and ankles taped. This was required in all contaminated zones except Cells 6 and 7 where plastic air suits were required. When leaving contaminated zones, clean-up personnel were directed to well defined check points where successive layers of clothing were removed and personnel were monitored. Personnel then showered and received a final check by Health Physics surveyors before being released. Frequent smearing of the change house area indicated that little or no contamination was spread into clean zones.

Before decontamination work was begun on each area, easily removable equipment was carefully wrapped in plastic and moved to an outside decontamination pad. Equipment and supplies of low value were removed to the "burial ground" for disposal.

When decontamination of a new area was started, the first step was to remove gross amounts of contamination from highly contaminated spots to prevent spreading activity throughout the area. This was accomplished by two methods - vacuuming and sponging. Where a large amount of dust was present, vacuuming proved to be valuable. It was then necessary, however, to sponge the area to remove additional amounts of easily transferable contamination, and sponging alone proved to be just as effective as vacuuming and sponging. During the sponging operation it proved wise to replace sponges frequently with new sponges and to limit the amount of water used. Sponging of instrument tubing, wireways, instrument racks and electrical panels also proved effective.

The second step in the decontamination procedure was to thoroughly scrub all surfaces with detergent, water and stiff fiber brushes followed by thorough water rinses. Several passes of this type were usually required to remove the remainder of the transferable contamination.

The most difficult part of the decontamination procedure was the removal of nontransferable contamination that had become fixed to concrete, metal and painted surfaces and probed up to 800,000 d/m/100 cm^2. The use of chemical reagents, such as dilute HCl on concrete and dilute HNO_3 on stainless steel, was successful in removing this "fixed" activity in some cases. However, it was generally necessary to mechanically remove a layer of the contaminated surface before it would meet the contamination limits. Relatively smooth concrete floors such as existed in the control room were ground with terrazzo machines to remove a layer of concrete approximately 1/16 in. thick. The remaining "hot" spots were chipped out. In areas where the concrete floors were pitted such as in the make-up area it was necessary to chip out almost the entire floor and repour a new one. Painted surfaces were decontaminated by removing successive layers of paint until acceptable contamination levels were reached. In many cases it was necessary to remove all paint down to bare metal. Unpainted stainless steel surfaces were partially decontaminated with dilute HNO_3. Unpainted metal surfaces other than stainless steel were particularly hard to decontaminate. Surfaces had to be sanded and ground almost to a polish before specifications were met, and in many cases it was less expensive to cut out sections of contaminated piping and replace with new material.

During all phases of decontamination frequent smearing and probing by Health Physics surveyors were required to indicate progress and to evaluate the decontamination methods used. This was particularly important during the latter stages when it was desirable to concentrate only on the "hot" areas and not to expend effort on clean areas. The standards for a complete survey of an area require 1 smear and 4 probes with a gas flow alpha meter per square meter of projected surface. Usually, however, the surveys were more thorough than this. As an example, for one complete survey of the penthouse ceiling, which has a projected surface area of about 420 sq meters, a total of 2084 smears and 7,263 probe readings were taken. This averages about 4 smears and 15 probe readings/m^2 or 4 times the required amount. A complete survey of the penthouse ceiling required approximately 16 man-days of effort and the equivalent of 4-5 complete surveys were made during the decontamination of the penthouse ceiling alone.

5.0 DECONTAMINATION OF SPECIFIC AREAS

The next few figures will show a few of the areas that were contaminated during the November 20 incident and I will point out some of the areas that were difficult to clean up.

Figure 2 is a picture of the penthouse area which is located over the seven hot cells of the pilot plant and was the most highly contaminated area outside of Cells 6 and 7. The area is approximately 165 ft in length, 30 ft wide and 30 ft high and it contains instrument transmitter racks, cold make-up tanks, hot process equipment in lead brick cubicles, a quick disconnect panel and large quantities of instrument tubing, water, steam, air and process piping. This figure also shows the building structural steel and support beams for a 10 ton crane. This ceiling proved to be one of the most difficult areas to decontaminate. Figure 3 is another view of the penthouse ceiling and shows the portable scaffold that was installed to facilitate the ceiling clean-up. A number of methods for removing the fixed contamination from the painted surfaces of the penthouse were tried. These include scrubbing with stiff brushes, detergent and water, scrapping off all loose paint, sanding by hand and mechanical sanders, but the only effective method found was to remove the paint almost completely with paint remover and paint scrappers followed by a good scrubbing with soap and water. This method was applied and proved effective on all painted surfaces.

Figure 4 is a picture of the cold solution make-up area and clearly shows the condition of the concrete floor resulting from acid spills and heavy traffic. The only way this condition could be decontaminated was to chip out the entire floor and repour a new one. This has been done in the make-up area and in addition a stainless steel liner has also been installed.

Figure 5 is a picture of the pipe tunnel where a number of pulser drive units are located. Contaminated grease and oil were cleaned from these drive units with a commercial product called Gunk. The painted walls and ceiling were decontaminated with paint remover, while the stainless steel floor, piping and lead shielding were cleaned with dilute HNO_3.

6.0 RESULTS

Table 3 summarizes the manpower expended on the decontamination program to date and gives the final contamination status of the listed areas. The areas are listed approximately in an increasing order of contamination and it can be

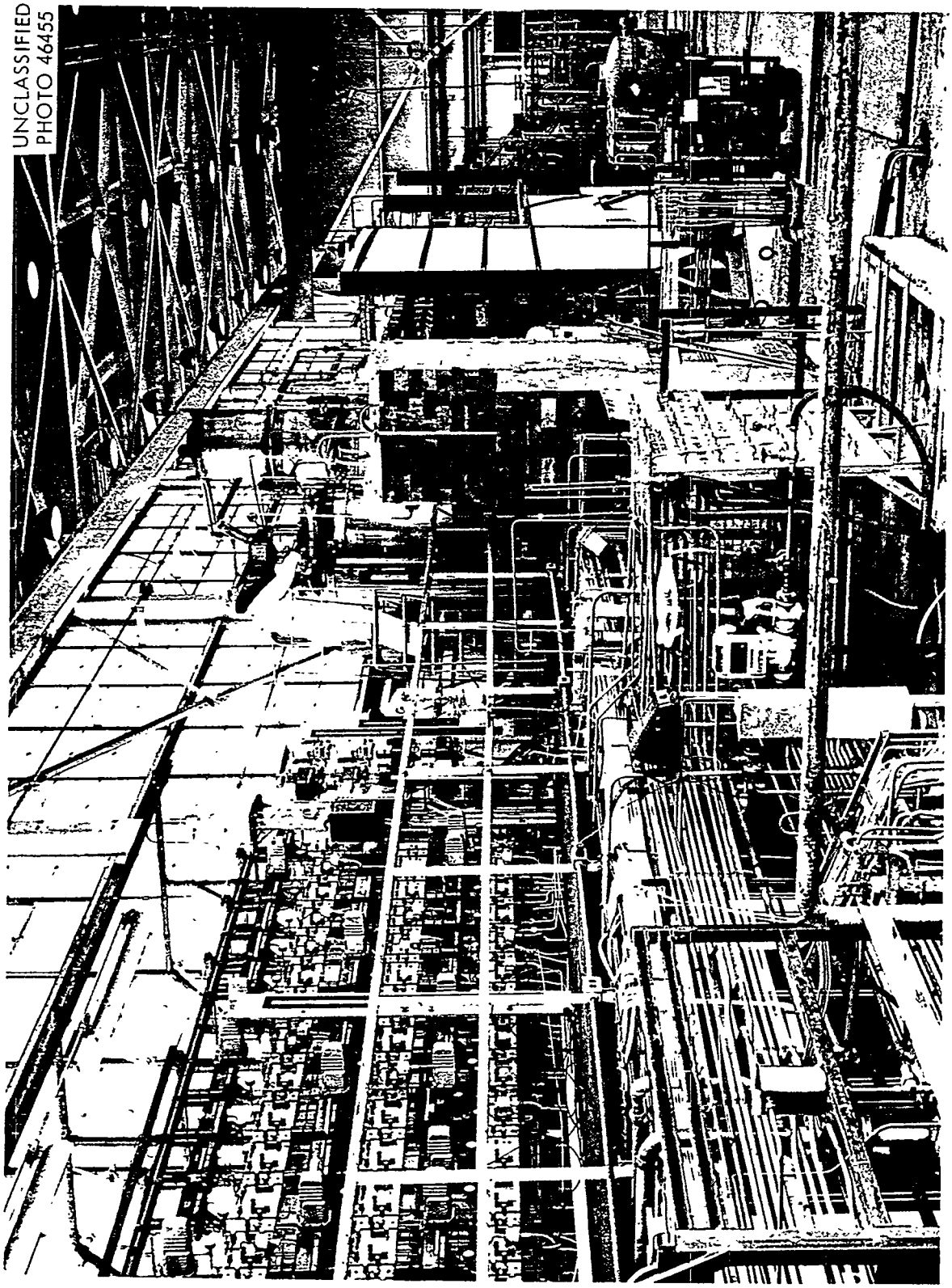

Fig. 2. Bldg. 3019 Penthouse Area.

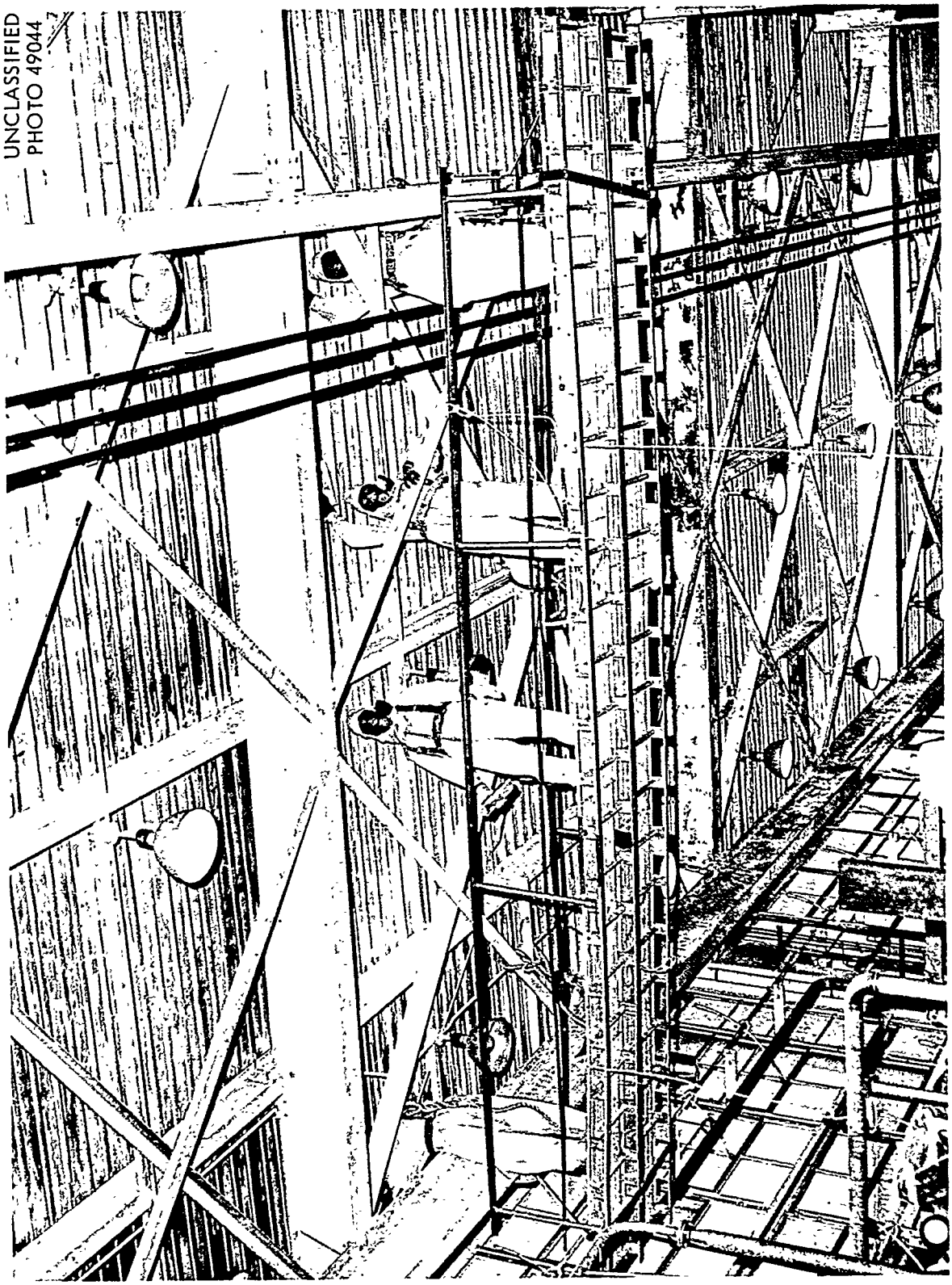

Fig. 3. Bldg. 3019 Penthouse Ceiling.

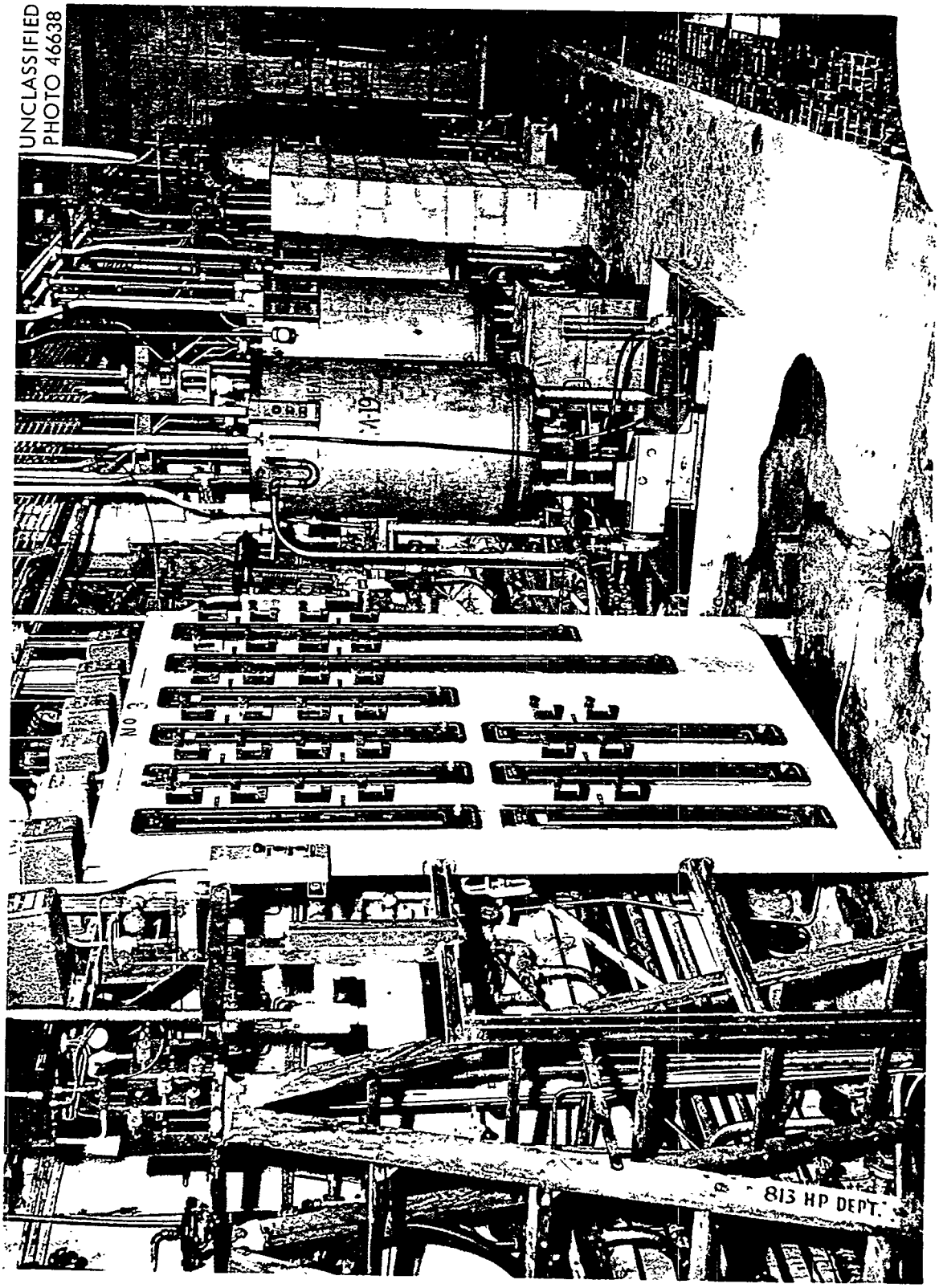

Fig. 4. Bldg. 4019 Cold Solutions Make-up Room.

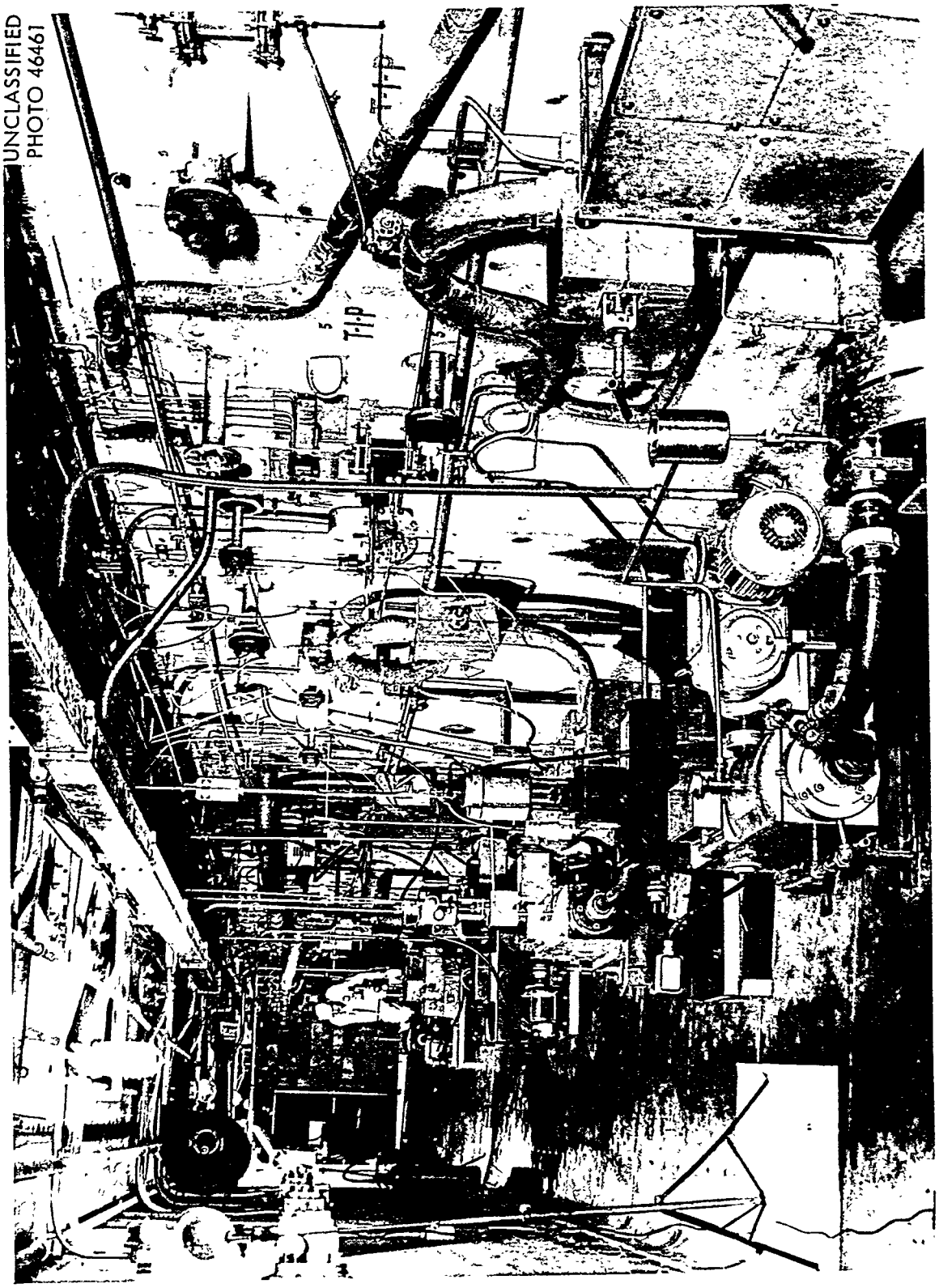

Fig. 5. Bldg. 3019 Pipe Tunnel.

seen that manpower expenditure varies directly as the level of contamination as might be expected. The total manpower expenditure amounts to 2067 man days with more than half of this total expended on decontamination of the penthouse. This manpower summary includes clean-up personnel only and does not include Health Physics surveyors and craft people employed to refinish the areas after they were decontaminated.

Table 3. Results of Decontamination Program, 7-12-60

Area	Man-Days Expended	Final α Contamination Status, d/m/100 cm^2				Fixing Agent on		Protective Clothing Required
		Transferable		Nontransferable				
		Avg	Max	Avg	Max	Floor	Walls & Ceiling, Coats of Paint	
Attic	59	7	330	~300	3000	3 coats of paint	3	Minimum
Offices	73	3	18	-	300	None	None	None
Room 100	202	8	128	~300	3000	Tile	3	None
Pipe Tunnel	180	18	228	~300	3000	None	4	Maximum
Sample Gallery	181	15	304	~300	3000	2 in. Concrete	4	Minimum
Make-up	212	25	254	~300	3000	6 in. Concrete	4	Minimum
Penthouse Wall, Floor	1160	265	8900	1312	3×10^4	2 in. Concrete	4	Maximum
Penthouse Ceiling		45	8054	1828	2×10^5	-	4	

Minimum - 1 pair coveralls, shoe covers, and gloves.
Maximum - 2 pairs each - coveralls, shoe covers, gloves, and 1 assault mask.

The next four columns list the final α contamination status of each area for transferable and nontransferable contamination. The only area to be decontaminated sufficiently to be classified as a noncontamination area without applying a bonding agent to the floor, ceiling and walls were the offices. The offices were cleaned to an average level of transferable contamination of 3 d/m with a maximum of 18. All other areas except the penthouse were cleaned to

painting specifications which are an average smear of 30 d/m with a maximum of 300 d/m for transferable contamination and a direct reading average of 300 with a maximum of 3000.

The last complete survey of the penthouse floor, walls and ceiling revealed that the contamination level in this area still exceeded the painting specifications even after the large amount of work that had been done there. To further decontaminate the penthouse floor, a rotary scarifier was used to remove a 1/8 in. layer of concrete. The entire floor was then probed for hot spots and areas probing > 3000 d/m/100 cm^2 were chipped out with air hammers. The floor area was then reprobed for hot spots and any found were removed by chipping.

Further decontamination of the penthouse ceiling was handled as follows:

Step #1. A thorough resurvey of at least 10% of the surface area was made and all areas exceeding a direct probe reading of 3000 d/m were marked.

Step #2. All marked areas were cleaned down to < 3000 d/m and rechecked by Health Physics.

Step #3. Steps #1 and #2 were then repeated.

After this procedure was completed, the penthouse was released for painting. After the areas had been cleaned down to the required contamination levels, the remaining activity was fixed to the surfaces with a bonding agent as listed in these next two columns. Floors were refinished with tile, paint or concrete and walls and ceiling received the number of paint coatings as indicated. All painted surfaces were color coded. That is, the first coat of paint was either orange or red to serve as warning to repaint when the outer layers of paint begin to wear or flake off.

The last column of the table lists the protective clothing now required for entry into each area. The minimum requirements are 1 pair of coveralls, shoe covers and gloves. Maximum protective clothing is required for the pipe tunnel because the U-233 storage area has not been cleaned and the basement has not been painted.

7.0 STATUS

The present status of Building 3019 clean-up is as follows:

1. All areas outside of the hot cells have been decontaminated, painted or are in the process of being painted except:

   a. The uranium storage area in the pipe tunnel.

   b. The basement.

   c. The uranium isolation laboratory.

2. Cell 1 has been decontaminated and released for normal operation.

3. Cell 2 has been decontaminated and painted and high velocity air samples are being taken before work may be performed without masks. The stainless steel floor requires additional cleaning.

4. All equipment has been removed from Cell 3 and the walls and ceiling cleaned below an average transferable contamination level of 300 d/m/100 cm^2. Areas above 400,000 d/m/100 cm^2 are detectable with the direct reading gas flow meter and further clean-up may be required.

5. No clean-up work has been done in Cells 4 through 7 at this time.

WTMcC:lj